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Oral
Increasing the density of Global Navigation Satellite System Radio Occultation (RO) with Smallsats as well as increasing the quality of RO with the next generation COSMIC-2 constellation is expected to improve analyses of the atmospheric state, which is crucial for numerical weather forecasts. RO provides high vertical resolution observations of water vapor which could be useful in determining the depth of a moist layer and its vertical structure, for example in atmospheric rivers (ARs). The multiyear AR Recon campaign has extensively sampled ARs and their surrounding environment over the northeastern Pacific with dropsondes, and select data from three recent winter seasons (2018, 2019, and 2020). Atmospheric rivers are a challenging environment for RO because of the very strong horizontal gradients in moisture and temperature in these frontal systems, and the dense dropsonde dataset presents a unique opportunity to quantify errors under those conditions. Spire provided RO profiles during AR Recon 2019 as part of the NASA Smallsat pilot evaluation, and these profiles are evaluated as well as COSMIC-2 RO profiles and the other operational RO missions from the 2020 winter season. All of these RO datasets are compared to the aforementioned dropsondes and the ECMWF Renalysis 5 (ERA5) reanalysis product.
The differences between dropsondes and ERA5 provide a useful reference. The dropsonde data have near zero mean and larger standard deviations inside an AR (2.6%N) than outside (1.8%N) near, near 3-4 km in height. All of the RO datasets examined have mean differences with ERA5 of less than 0.5 %N in the upper troposphere and negative biases are present in the lower troposphere. However, the Spire data have radically different characteristics in the lower troposphere, being extremely smooth compared to that of the other RO datasets and dropsondes. In the Spire RO data, the sign of the mean bias oscillates with height in the lower troposphere, and this is greatly accentuated outside an AR, because the overly smooth nature does not capture sharp gradients at the marine boundary layer. The COSMIC-2 and Spire RO data have much larger standard deviations relative to the ERA5 than the other currently operational RO missions throughout most of the troposphere, with the largest values found in COSMIC-2. In the Operational RO and

COSMIC-2 datasets, larger biases are found inside an AR than outside. Surprisingly, the depth of penetration into the lower troposphere is greater inside an AR than outside in all RO datasets examined.

Recent studies have shown Spire’s RO profiles to have comparable performance and number of observations rejected by models to other constellations in the upper troposphere. However, the apparent similarity in performance in the lowest levels may be an artifact of the unrealistically smooth nature of the Spire RO profiles. This should be investigated further before relying on the data for improved lower tropospheric analyses.

Presentation file

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